2145 Teucrium foliis ovatis acute inciſoſerratis glabris, floribus axillaribus geminis caule, erecto. Linn. Sp. plant. 790.

2146 Tithymalus Linariæ folio, lunato flore. Mor. H. Reg. Bleſ.

2147. Valeriana ſylveſtris major altera, fol. lucido. H. Reg. Par.

2148. Veratrum racemo compoſito, corollis patentiſſimis. Linn. Sp. plant. 1479.

2149 Veronica racemis lateralibus, foliis lineari lanceolatis pinnato dentatis. Linn. Sp. plant. 17.

2150 Volkameria ramis inermibus. Linn. Zeyl. 231.

XVI. *A Courſe of Experiments to aſcertain the Specific Buoyancy of Cork in different Waters: The reſpective Weights and Buoyancy of Salt Water and Freſh Water: And for determining the exact Weight of Human and other Bodies in Fluids.* By John Wilkinſon, *M. D. F. R. S. of* London *and* Gottingen.

[*Experiments to determine the Specific Buoyancy of Cork in River Water.*]

Experiment I.

Read March 14, 1765. SIX cubes of good cork, every one meaſuring an inch ſquare, as nearly as they could poſſibly be aſcertained, with a graduated

duated gage of cork faſtened to a point of each, ſeverally weighed as follows;

	Grains
N° 1	49
2	47 $\frac{1}{2}$
3	47
4	46 $\frac{1}{2}$
5	46
6	43
Sum of Weights	279 $\frac{1}{2}$ Grains.

the medium weight, being the exact weight of a cubic inch of cork is 46 $\frac{6}{7}$.

Experiment II.

N° 1, 2, 3, 4, formed a float named A, being 190 grains of cork, which was faſtened to a medallion of lead, weighing two ounces, by a wire that weighed eight grains; theſe being put into a deep jar of Thames water, taken above the new bridge, the lead weighed exactly 44 grains; ſo that 190 grains of cork ſupported preciſely 916 grains of lead in river water.

Experiment III.

The float was left in the ſame water, immerſed by the medallion for the ſpace of 48 hours, with a view of obtaining a preciſe knowledge of the quantity of water the cork might imbibe; how its buoyancy might be affected; and how much extenſion it might acquire from a certain continuance under the water.

It was ſomewhat ſurpriſing to find, that after this period of immerſion the cork had not, as might have been expected, loſt any force of buoyancy; but on the contrary, it had actually gained two grains, and was found to ſupport 918 grains of lead: which muſt be attributed, it may be preſumed, to an expanſion of the air contained in the cork, acquired from its immerſion in the freſh water.

To be further informed how cork would be affected by a continued immerſion, the ſame float, after weighing, was again immerſed in the ſame water, for the ſpace of 48 hours longer. And now the water was found to have penetrated its receſſes and cavities, in ſo much that its buoyancy had decreaſed 11 grains, and it then only ſupported 905 grains. This decreaſe may poſſibly be attributed to a greater imbibition in the cork, and a greater penetration given to the water, by its having been now 96 hours in a chamber, with a fire in it, by which it might be warmed. This float A being taken out of the water, wiped, and laid in a dry place for 24 hours, weighed 211 grains, having gained by abſorption 21 grains of additional weight.

Experiment IV.

The float, in this ſtate, having been 24 hours out of the freſh water, was now put into ſalt water brought from the North Foreland, in which it was found to ſupport the weight of 954 grains, of a leaden medallion, having the power of buoying up 38 grains more in the ſea water, than it did in the river water, with which it was nearly ſaturated at the time of its immerſion in the ſea water.

After an immerſion of 48 hours in the ſalt water, this float (A) loſt 16 grains of its buoyant power; and having been 72 hours in the ſalt water, upon weighing of it again out of the water, being wiped, but full of water, it was found to weigh 241 grains, having gained 30 grains. After being nine hours out of the water, in a dry room, it weighed 213 grains, having loſt 28 grains. This float (A) having been 76 hours in the ſalt water, in which it then ſuſtained 949 grains of lead was removed, thus ſaturated with the ſea water, into a veſſel of freſh river water. and was found to ſuſtain 923 grains only, being 26 grains leſs than it bore up in the ſalt water; and yet it muſt be obſerved, that this float had been ſaturated with freſh water before it was immerſed in the ſalt water.

Experiments made to diſcover the Specific Buoyancy of Cork in Salt Water.

Experiment V.

Not content merely to know the buoyant power of cork in freſh water, it was next tried in ſea water. Four cubes, being each an inch ſquare on every ſide, made of the beſt ſound compact cork, with diſtinct gages made of cork, and adjoining, as in the preceding experiments, were prepared, each weighing as follows;

	Grains
N° 1	42
2	42 ½
3	54
4	53
5	43
Amounting in all to	234 ½ Grains.

theſe

theſe being united, formed one float (marked B) that they might the nearer reſemble the texture of the cork jacket. A veſſel of ſea water taken up near the North Foreland being then provided, the float was found to ſupport in it a leaden medallion weighing 1048 grains. When it had continued in the ſea water for 48 hours, it exactly ſupported 1024 grains, having, by being in the ſalt water, for that ſpace of time, loſt 24 grains of its buoyant power.

From this experiment we learn, that the ſalt water inſinuates more into the ſubſtance of cork than freſh water doth, which may perhaps be attributed to its oilyneſs, * oil being, as is very well known, more ſubtil and penetrating, than water; it could not therefore be expected that the cork ſhould therein retain its force ſo vigorouſly, for ſo long a time, as it doth in the freſh river water; and, on weighing, it was found to loſe $\frac{1}{359}$ of its buoyancy in 48 hours.

But then we are further to obſerve from the above, that the ſea water ſupports a greater weight, and gives more buoyancy to the cork float than freſh water, in the proportion of 353 to 359; for a float weighing 44 grains, ſupporting 353 grains of lead in freſh water, buoyed up 359 grains of lead in the ſea water, being more by ſix grains. And it is to be noted, that the ſea water taken up at the North Foreland is not ſo much impregnated with the marine principles, as that which is taken up at a greater diſtance from freſh water rivers, which decreaſes in its buoyancy in

* Vid. Macellinus. Pliny (Lib. xxxi. Cap. 7.) P. Bourges (Lett. Miſſionaires, Octav. Edit.) and Dr. Hales.

proportion to its vicinity to or mixture with rivers; for on evaporating it yielded only two drachms and one grain of ſalt to a pint, which is leſs by ſeven grains than is yielded by that taken up at the Iſle of Wight.

Experiment VI.

The float B being continued in immerſion in ſalt water for 72 hours, it had loſt 26 grains more of its buoyant force, loſing in the firſt 48 hours 24, and in the 24 ſucceeding hours two grains only; from which it appears, that, after the cork has been in the water for 48 hours, its abſorption becomes leſs than before, in proportion as 12 is to 1.

This float having continued in the water for 78 hours, each piece of cork, being wiped very dry on its ſurface, but not ſqueezed, weighed as follows;

N°	1 weighed	55 ½ Grains	having gained	12 Grains
	2	47		4 ½
	3	66		12
	4	59 ½		5 ½
	5	51 ½		8 ½
All	5 weigh.	279 ½	gained	42 ½

Being then deſirous to know if any quantity of ſalt had inſinuated into the pores of the cork, and if ſo, how much; the above float was hung up to dry in a warm airy room, where it was not far from the fire, for the ſpace of 48 hours; when it ſeemed to be

be quite dry, and each piece being weighed, was found as follows;

		Gr.		Gr.
N° 1	weighed	45	the ſalt ſuppoſed to be contained was	3
2		46		$3\frac{1}{2}$
3		59		6
4		55		2
5		44		1
All 5	weigh.	249	ſalt gained	$15\frac{1}{2}$

But on their being hung near a fire for 72 hours, until perfectly dry, no ſalt appeared to be imbibed, for the above numbers weighed as follows; having loſt by extraordinary dryneſs about $\frac{1}{20}^{th}$ of their firſt weight.

N° 1	weighed 40 Grains,	having loſt 2 Grains
2	42	4
3	54	3
4	53	3
5	43	3
	232	15

Experiment VII.

For the ſake of the greater exactneſs, another float (marked C) was made of two cubes of cork, amounting to 164 grains; the larger 118, and the ſmaller 46 grains; this was put into the ſame veſſel of river water, after it had been 96 hours in a warm chamber, and ſupported a medallion of lead weighing 766 grains; it was left in the water for 36 hours longer, and weighed again, when it was found to ſupport 754 grains, having loſt 12 grains of its buoyant force in that ſpace of immerſion. From this ſecond experiment does it not appear, that this loſs of

of buoyancy was principally owing to the warmth the water had got by ſtanding in a warm room, as was hinted at before, which was further proved by the thermometer?

Two other floats, of 44 grains of cork each, having been 72 hours in river water, weighed each 53 grains, having gained nine grains by the immerſion. Being laid to dry for 24 hours after, weighed 46 grains, having relinquiſhed ſeven grains each.

The float C, being wiped and put into a dry place for 24 hours, was found to weigh 183 grains, having gained 19 grains of weight. The float, in this ſtate, was then immerſed in ſalt water, and was found to ſupport 864 grains, being 110 grains more than it ſupported in freſh water, after it had been ſaturated therewith; C, being left in ſalt water 48 hours, was, upon weighing, found to have loſt ſix grains of its buoyant power. This float C, having been 72 hours immerſed in the ſea water, was found, after being well wiped, to weigh 203 grains, having increaſed in weight 20 grains by immerſion. After being nine hours out of the ſalt water it was found to weigh 188 grains, having loſt in that time 15 grains.

Experiment VIII.

A medal of lead, weighing one drachm when out of the water, was found, on being weighed in river water, to be 54 grains and a half; being leſs by five grains and a half than out of the water. The ſame medal being weighed in the ſalt water was found to weigh 53 grains and a half. The difference between its hydroſtatical weights being preciſely one grain, or $\frac{1}{54}^{th}$ more in river water than in ſea water.

Expe-

Experiment IX.

A phial of river water weighed exactly 82 grains; the ſame veſſel of ſea water weighed exactly 84; the difference was two grains, or as 41 to 42.

Under all theſe experiments, theſe cubes of cork did not ſeem to have gained any meaſurable extenſion; yet it is certain the volume of cork, like moſt other ſubſtances, will alter by the imbibition of humidity.

The aſſertion which has commonly been advanced, that the bodies of men in general are ſpecifically lighter than their reſpective volumes of water, is not quite perfectly founded in truth; accurate experiments, minutely obſerved, will ſatisfactorily evince the contrary to be true. Weighing hydroſtically the human body cannot be ſo precitely performed, as to permit us to draw any certain inference therefrom, as evidently appears from the imperfect attempts which the ingenious Mr. John Robinſon made for that purpoſe (ſee Philoſophical Tranſact. Vol. L. Part II. Page 30); on peruſing of which, and the author's ingenuous confeſſion of the inaccuracy of his experiments, it occurred, that a more conciſe and eaſy method of obtaining a certainty in this particular, might perhaps attend the following attempt to diſcover the ſpecific gravity of the human body in water.

Experiment X.

After having made the foregoing experiments, with a view of aſcertaining the ſpecific buoyancy of cork, and alſo the alteration it might undergo from being immerſed in river or ſea water, we proceeded to the more important examen, to diſcover the preciſe quantity of cork neceſſary to ſuſtain a man in the water.

water. For this end, 22 pieces of the beſt cork, ſuch as is directed to be uſed for the jackets, * were provided; theſe were of different weights, from one ounce down to one ſcruple; ſo that by means of a ſtring to which they were occaſionally faſtened, one might eaſily learn what weight they would ſuſpend in the water, and what weight they would not ſuſpend. This being done, the next buſineſs was to find a proper perſon to make the experiment upon; for the accuracy of which it was judged proper to ſelect a man of the ſmaller ſize (as our ſeamen are ſeldom large) that was not very fat, becauſe fat people are more buoyant than lean or bony perſons; one that could ſwim, that he might go through the experiment with propriety, and without fear; one, therefore, was fixed upon, who was plump and muſcular, not very bony, but moderately ſo;

His height was five feet two inches;
His waiſt meaſured two feet ten inches;
His weight was one hundred and four pounds.

Thus fitted out, he ſtripped naked, and ten ounces of cork being tied about his neck and breaſt, he committed himſelf to the river Thames, near Chelſea, in a place where the water was about a foot below his depth; but he could not keep his head above the ſurface without employing his art, though he found not much art required to do it: another ounce of cork was therefore added, and he perceived himſelf raiſed thereby, ſo as now to be the more able to keep himſelf above the water, but yet he went ſlowly to the bottom, unleſs he took care by ſwimming to prevent it. For this reaſon another ounce of cork was

* The cork jackets propoſed for ſaving the lives of ſeamen and others in ſhipwreck are here meant.

applied,

applied, but ſtill he ſunk, though more ſlowly than before; and it was plain to be obſerved, that the point between that manner of ſinking and ſwimming was balanced with ſuch extreme nicety, that the ſmalleſt addition of cork would determine in favour of buoyancy: accordingly half an ounce was added, and this weight ſupported him in a vibrating ſtate; but by the ſuper-addition of one drachm and two ſcruples more of cork, he found himſelf very able to keep above water, in a living poſition, without any help from his art of ſwimming, and that it required ſome ſmall pains to immerſe himſelf. It therefore reſults from this experiment, that twelve ounces, five drachms, and two ſcruples, or 6100 grains of cork, ſupported this man in river water; 6100 grains of cork are equal to 163 $\frac{30}{37}$ cubic inches; which appears, by a calculate drawn from the ſecond of the foregoing experiments, to be able to ſupport 63 ounces, five drachms, and eight grains of lead, which muſt be, therefore, the exact weight of this man in river water. By comparing this calculation with the above experiment IV. made in the ſea water, we ſhall find that this man weighed 60 ounces, three drachms, and 21 grains; or four pounds, 12 ounces, three drachms, and 21 grains, requiring 12 ounces and 21 grains of cork to ſupport him, in ſea water. It muſt however be obſerved, as we have already intimated, that the ſame quantity of cork which ſupports a fat, or very plump perſon, in the water, will not ſuffice to buoy up a lean perſon, although their weights, out of the water, be equal.